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A CASE OF HERMAPHRODITISM IN SPELERPES BISLINEATUS.

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Hermaphroditism among *Anura* seems to be comparatively common. Ecker and Wiedersheim's "Anatomie des Frosches," as revised by Gaupp, devotes several pages to the subject, dividing it into various types, the most common being that in which the glands are essentially male with female elements.

Miss King ('10) in her paper on anomalies in the genital organs of toads, says: "Evidently hermaphroditism occurs much less frequently among the *Urodela* than among the *Anura*, as only two cases have as yet been reported for this group of Amphibians. La Valette St. George ('95) has given a brief description of a case of hermaphroditism in *Triton tæniatus* and Knappe ('86) has noted the presence of a Bidder's Organ in a young salamander; neither investigator gives any details regarding the structure of the ovo-testes in these forms."

Knappe mentions *Triton* also in his investigations but seems to have found a Bidder's Organ only in a two-year-old *Salamandra maculata*. Concerning the frequency of occurrence of hermaphroditic salamanders, La Valette St. George says: "Für die Urodelen liegen, soviel mir bekannt, noch keine Angaben über Zwitterbildung vor.

"Spengel will solche niemals angetroffen haben, obgleich er zahlreiche Salamander und Tritonen zerlegt und allein von Triton cristatus über 100 männliche Individuen untersucht hat."

While collecting data concerning the spermatogenesis and age of attainment of sexual maturity of *Spelerpes bislineatus*[1] I found that a series of sections through the testes of a 46 mm.

[1] Although this species has long been called *bilineatus*, Dr. Green in his original description of it (Jour. Acad. Nat. Sc. Phila. Vol. I, Pt. II, 1818) gave it the name of *Salamandra bislineata*. With the change in generic name the masculine ending was adopted and the species is correctly *Spelerpes bislineatus*.

larva, collected in September, 1913, contained several eggs. The larva was nearly of adult proportions and presumably would have undergone metamorphosis the following summer.

Fig. 1, *B*, is from a drawing of the pair of gonads and kidneys, made with an Abbé camera before imbedding. It reveals the peculiarities of the glands when compared with Fig. 1, *A*, which is a drawing, at the same magnification, of a normal pair of

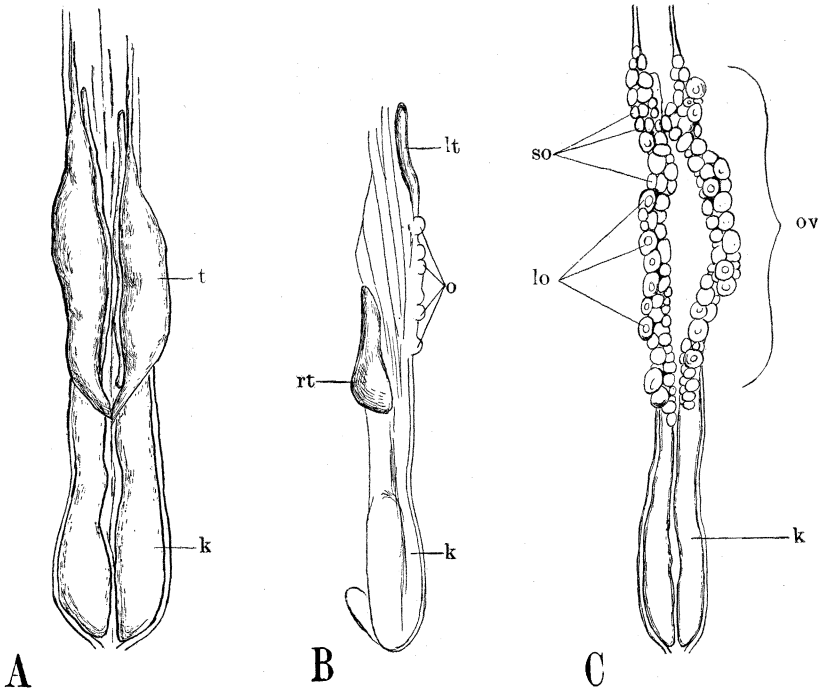

FIG. 1. *A*. Testes and kidneys of normal 48 mm. larva. *B*. Gonads and kidneys of hermaphroditic 46 mm. larva. *C*. Ovaries and kidneys of normal 46 mm. larva. These gonads and kidneys are from larvæ collected in September. Ventral view, × 7½. *k* = kidney, *lo* = largest ova, *lt* = left testis, *o* = ova, *ov* = ovary, *rt* = right testis, *so* = smaller ova, *t* = testis.

testes and kidneys of a 48 mm. larva. The original of Fig. 1, *B*, being merely a hastily made outline drawing and the testes having been very small, I noticed the hermaphroditic condition only on careful study of the sections.

A comparison of Fig. 1, *A* and *B*, shows that, in the abnormal specimen, neither testis is fully developed. The hermaphroditism

is of two types. Macroscopically, the anterior part of the left gonad, which is much reduced in size, resembles the normal testis in texture, though not in shape, while the posterior region is distinctly like an ovary. The larger ova in this latter region, indicated in outline in Fig. 1, *B*, are six in number.

Fig. 1, *C*, is a camera drawing of the ovaries and kidneys of a normal 46 mm. larva, collected in September, showing the arrangement of eggs, for comparison with their arrangement in the posterior region of the left gonad of the hermaphrodite. In each normal ovary the larger ova lie approximately in two rows, one lateral and one medial. A dozen or fifteen on each side are appreciably larger than the others. These larger ones, as may be deduced from a comparison with the ova in specimens of adult female *Spelerpes*, collected in September, are of the size and state of development which indicate that they would normally have been deposited a year from the following spring as the first brood of this individual, while the next smaller ones would have been deposited two years from the following spring.

The larger ova in the left gonad of the hermaphrodite are about the size of the smaller ova in the normal ovaries, though their irregularity in shape, especially where large numbers of eggs are packed together, makes exact measurements impossible. The ova of both the normal specimen and the hermaphrodite have their long axes parallel to the longitudinal axis of the body. This diameter, as measured from sections, is .15 to .20 mm. while the shorter diameter, at right angles to the long axis, averages about .12 mm. The largest ova found in the hermaphrodite are, in development, a year behind the largest ova in a normal female having the same total length, collected at the same time, and therefore, presumably, of the same age. Beside these ova, there are oögonia in the left gonad of the hermaphrodite, similar to those in the normal ovary which have not yet begun to elaborate yolk (Fig. 2). The relation of ova to follicle cells and to peritoneum in the hermaphrodite is like that in the normal ovary.

Although smaller than the right testis, the anterior portion of the left gonad has somewhat the structure of the normal male gland. The elongated mass is composed of too few loulebs to

have the usual arrangement about a collecting duct. The cells, showing no signs of division to form cysts, which is the immediate preparation for spermatogenesis, are not as far advanced in their development as the germ cells of a normal male larva several months younger than the hermaphroditic one. The left gonad shows throughout a retarded development.

The right gonad, on the other hand, although smaller than the normal testis of an individual of the same size, seems to

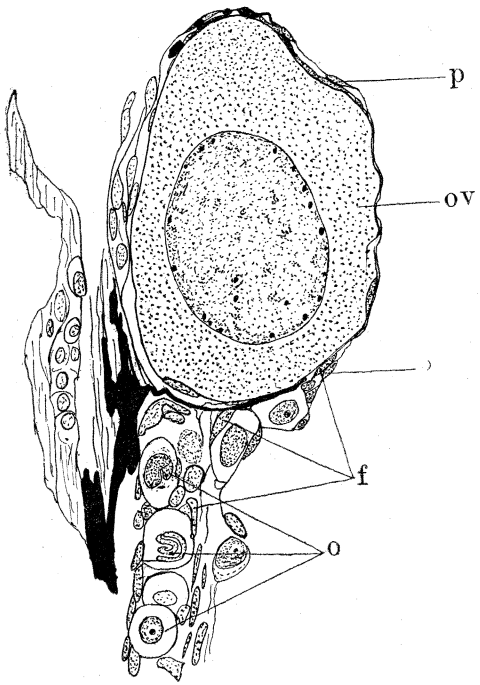

FIG. 2. Horizontal section through posterior region of left gonad of hermaphrodite, × 280. *f* = follicle cell, *o* = oogonium, *ov* = ovum, *p* = peritoneum.

be, in general, normal in structure and in its cellular development. However, it shows another sort of hermaphroditism. Two ova are, in this case, found in the otherwise apparently normal testis, each one completely filling one lobule, which would normally contain a large number of male cells (see Fig. 3). These ova are about two thirds the size of those found in the right gonad. All the lobules are divided into cysts, with the excep-

tion, of course, of the two which contain a large ovum apiece. Most of these cysts are composed of spermatogonia of the last generation, having round or oval nuclei with the chromatin arranged in an irregular network. Nucleoli appear in a few cells of one section. The spermatogonia resemble Kingsbury's Figs. 1 and 2 ('02). In a few cysts, all the cells are undergoing mitosis. These do not resemble the maturation mitoses described for *Desmognathus*, and are probably spermatogonial divisions.

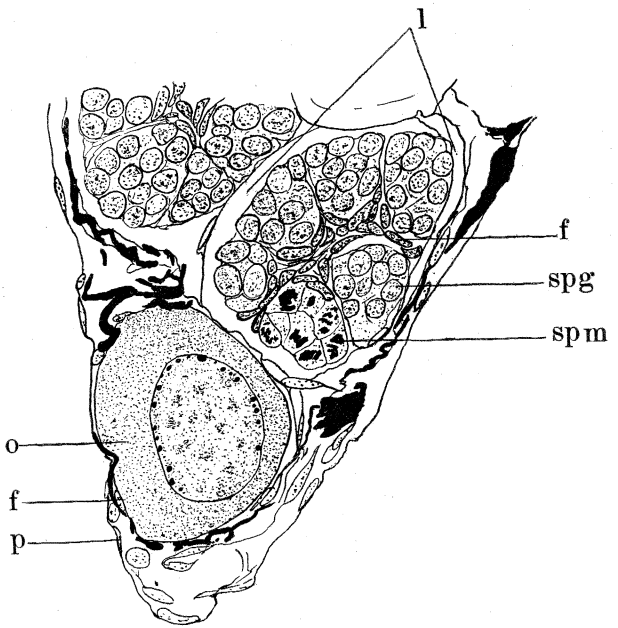

FIG. 3. Horizontal section through right gonad of hermaphrodite, × 280. *f* = follicle cell, *l* = lobule, subdivided into six cysts of spermatogonia, *o* = ovum, *p* = peritoneum, *spg* = spermatogonium, *spm* = spermatogonial mitosis.

In other cysts the nuclei are in the "contracted" condition, described by Kingsbury (Fig. 18), occasionally occurring in *Desmognathus fusca* at the beginning of the period of growth of spermatogonia into spermatocytes and more commonly, in that species, in the last generation of spermatocytes. Fig. 3 shows an egg filling one lobule and surrounded by follicle cells. In this case, as well as in the left gonad, the relation to follicle cells and to peritoneum is normal. The adjacent lobules show sper-

matogonia, grouped in cysts, surrounded by long follicular cells. The cells of one cyst are undergoing spermatogonial mitosis. A great deal of pigment from the peritoneum appears in this section which was cut near the surface of the testis.

The germ cells of the right gonad seem to have reached a normal degree of development. The individual, collected in September, with a total length of 46 mm., would have undergone metamorphosis during the following summer. It is probable that the male *Spelerpes* attains sexual maturity in the fall after metamorphosis. Then this individual hould have reached maturity in a little over a year. The spermatogonia are just ready to commence the process of maturation. This process in *Desmognathus* takes about a year, while Kingsbury's observation that, in *Spelerpes*, regeneration of the lobule begins before the spermatozoa leave it, indicates that possibly the process of spermatogenesis requires even more time in *Spelerpes*. Then it may be supposed that these male germ cells of the right gonad would have become ripe spermatozoa at the normal time. The two ova in this gonad, however, are at least a year behind the normal development. In the left gonad, in which there is a greater abnormality, the development of both kinds of germ cells is retarded.

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